sea-shore ; the other, seeing in the same beds evidence of a recent and sudden upheaval of the land. Truth, probably, lies between these two extremes. The refuse of native feasts may certainly have been the origin of some few isolated patches, but many of the beds are by far too extensive not to have been formed in a natural manner during a submergence of the land. There is, however, so far as these observations extended, no evidence to show that any part of the island has risen with a sudden motion. Any upheaval which has taken place was most probably of a gradual kind, somewhat akin to that which is now supposed to be imperceptibly elevating the entire coast line of the Australian continent.

At Geilstov Bay, nearly opposite to Hobart Town, are situated some extensive beds of fresh-water limestone or travertine. Many of the shells therein, and some of the plants, are identical with some now living ; but there are others, of which no recent analogues are to be met with in any part of the island.

Art. XXXIII.—*On the Systematic Position of the Nardoo Plant, and the Physiological Characteristics of its Fruit.* By Ferd. Mueller, M.D., F.R.S.

[Read 29th September, 1862.]

The observations which I beg to offer to the Royal Society of Victoria on this occasion, have only but in a limited measure claims on originality, inasmuch as they are mainly founded on an essay by Dr. T. Hanstein, read before the Academy of Sciences of Berlin, in the beginning of this year. The essay referred to was transmitted by Sir Redmond Barry, who received it during his stay in Berlin from Professor Ehrenberg, and who expressed a desire that it should be translated and republished in Victoria. Dr. Hanstein reviews in this memoir the various described species of Marsilea, indigenous to Australia, and enters then at some length into a physiological treatise, explaining with great ability the organisation and the development of the Marsilea fruit. Of the physiological part of this essay, as highly important, I thought it desirable to submit a translation, abridged only in a few trifling points. In reference to the systematic part of the essay, I consider it however necessary to state briefly the reasons which induce me to regard the opinions advanced by Dr. Hanstein and his literary predecessors on the limitations of the Marsilea species as untenable. Dr. Hanstein, after referring to the touching incidents, under which after their heroic exploit Bourke, Wills, and King endeavoured to maintain their sustenance on the Marsilea fruit or nardoo, gives an accurate description of certain specimens of this fruit which he received from Dr. Richhard Schomburgk, of Buchésfelde, South Australia, and describes the species as a new one under the name of *Marsilea salvatrix*, a designation which could not have been nobler chosen if this species had real claims on permanent distinction.

All plants of a wide geographical range, adapting themselves to many varied influences both of climate and soil, undergo proportionate variations, and there are probably no other tracts of the globe where the power of nature to adapt its vegetable productions to varied conditions can be more instructively studied than in this country. We possess glacier regions, moist jungle forest, and draught-exposed desert tracts at some spots in close proximity, and again, in some instances, the transit of one of these geographical features to the other and therewith the change of generally diffused species of plants into marked varieties are sudden in the extreme.

In phytological journeys, which under the favour of circumstances it fell to my share to perform to a wide extent, both over the northern and southern regions of Australia, and equally over our snowy highlands and the low depressions of the interior, I enjoyed frequent opportunities of tracing the cycles of forms, which many of the widely spread plants of this country are apt to assume, often wonderfully discrepant in their external appearance, and yet so closely interchained by intermediate links as to afford some of the strongest proofs against the doctrine of the mutability of species.

The Marsilea, although not a child of colder regions, and hence not ascending to our alpine elevations, is otherwise so extensively distributed as to afford a striking instance of the fallacy to construct species on trifling exterior characters. We may in Australia observe this plant as well in the waters of the tropical coast forests, as in and around swamps, lakes, and lagoons of the otherwise dry interior tracts. In depressions of the latter, subject to periodical inundations, it grows often very gregariously, and there it is also where, after the recess of the water the fruit is so copiously developed as to render it a possibility for the desert natives to draw it into use as one of the constituents of their vegetable diet.

It may be well imagined, that a plant dispersed like the Marsilea over so wide a range of country, is altering much its form according to circumstances, yet in watching long and closely the plant in its native state, it becomes to me equally evident, that all the Australian Marsileæ, as far as seen by myself, are referable to one species, unless the internal structure of the sporangia, which I had not always an opportunity of examining, should yield distinctive notes by which some of the forms could be unfailingly recognised. Already Robert Brown, in his Golden Prodromus, published in the year 1810, of which the world has unfortunately only seen one volume, comprising not more than about one-third of the *phænogamous genera* of the Australian Flora, identified without any doubt the typical Linnean *Marsilea quadrifolia*, as indigenous to the vicinity of Port Jackson. Not having seen, at that early period of botanical investigation in Australia, any intermediate forms, he added two new species, viz., *Marsilea hirsuta* and *Marsilea angustifolia*, found by him simultaneously at Port Jackson; the latter, according to his observations, extending thence to the tropics.

The members present may, from the series of specimens of Marsilea exhibited on this occasion out of our state herbarium, form an opinion how far the diagnostic notes offered for these two additional species can be admitted as reliable, when it is borne in mind that the differences rest not on internal carpological characters, but merely on indument, form of leaflets, and proportionate length of fruit-stalks. The variety designated by R. Brown, as *Marsilea hirsuta*, extends more widely over Australia than any other, it being that state of *Marsilea quadrifolia* frequently but not always produced by the recess of water, when generally the plant assumes a silky hairiness; it is also, as already remarked, this variety which so abundantly fructifies, the aquatic form being often devoid of fruit. The variety named by R. Brown, *Marsilea angustifolia*, I have found hitherto in Arnhemsland only, where it grows in still lagoons, and varies according to the depth of water much in length, specimens having been measured nearly two feet long. Amongst the forms preserved in our herbarium, occurs also the *Marsilea erosa*, remarkable for the irregular denticulation of the anterior margin of the leaflets, but by no means specifically distinct from *Marsilea* *quadrifolia.* This variety was originally found in India, but is also not rare with us. As Australian species, we find further enumerated Sir William Hooker's *Marsilea macropus,* a name altered by Professor Alexander Braun into *Marsilea Drummondi* (Linnæa xxv. 721), the designation being preoccupied by Professor Engelmann for a West American plant. Another species simultaneously mentioned by Professor Braun, and to which the name of the author of this paper was given, proves equally untenable. It would appear that the distinctions of all these assumed species are drawn from no other points but external form, size, and indument; and having seen endless transitions from one to the other, I cannot but maintain, that alike to at least some of the extra Australian Marsileæ, these are all representing forms only of one species, widely distributed over the warmer temperate and tropical parts of the globe, extending from near the middle of Europe to South Africa, and Middle and South Asia, thence throughout Australia (although seemingly not advancing to Tasmania and New Zealand), and occurring likewise from the southern parts of North America, at least as far south as the Brazils. The supposition of the specific identity of all these plants is considerably strengthened by the well-known fact that many aquatic plants are truly cosmopolitan.

The nutritive properties of the Marsilea fruit are evidently very scanty. It seems to contain but slight traces of protein combinations and but little starch, its nourishing property resting mainly on a mucilage, pertaining to a certain extent of that of the seed-testa of flax, cress, quince, zygophyllum, &c.

Before I finally proceed to the translation of Dr. Hanstein's Physiological Notes, I would beg to observe, that to Dr. Beckler the credit is due of having pointed out, first of all, when releasing Lyons and Macpherson from their perilous position, that the Marsilea fruit formed part of the food of some of the aboriginal inland tribes, the use of the plant having providentially been communicated to Lyons and his companion by the natives. Previously we were not aware of the economical utility of this kind of fern. The Marsilea may not inappropriately receive the vernacular name, clover fern, its foliage (although consisting always of quaternate leaflets) and its habit bearing considerable resemblance to several species of trefoil.

PHYSIOLOGICAL OBSERVATIONS.

Already in the winter, 1834-1835, the surprising observation was made by Professor Alexander Braun, how the sporangia utricles of the Marsilea fruits are protruded from their receptacles by the expansion of a gelatinous placenta. The latter became visible in the attempt of soaking the fruit for more careful examination, and for the purpose of effecting eventually its germination; this took place in so remarkable a manner, that it may not appear superfluous to refer once more to the process, especially since only the illustrations furnished by Alexander Braun, after his first communication on the subject in "Der Regensburger Botanischen Zeitung," 1839, p. 298, are hitherto published, the details of the observations on *Marsilea pubescens* being solely illustrated in the "Exploration Scientifique d'Algérie, Botanique," pl. 38, fig. 21-32, and remained unexplained by description. After longer maceration of the fruit, Alexander Braun observed that the valves of this and allied species were seceding, a long, tender, gelatinous, vermicular body protruded, from which on both sides opposite to each other the sporangia utricles or sori expanded. A short explanation of this process, from drawings of Alexander Braun, is given by Professor Schnitzlein, in his "Iconographia Familiarum Regni Vegetabilis," fasc. 2, f. 4, 7, 8, additions to the illustrations being furnished by Bischoff and Schnitzlein.

Similar observations were made by Esprit Fabre ("Annales des Sciences Naturelles, 1837, vii. 221; 1838, ix. 115, t. B.), and by Mettenius ("Beitraege zur Kenntniss der Rhizocarpeen," 1846), who fully explained the development and structure of the fruit of this and the allied genera.

One of the fruits (transmitted by Dr. Schomburgk) in order to facilitate the ingress of water was slightly split at the ventral suture and was then boiled for about a quarter of an hour in water, when the unusually long (placental) cord, consisting of hyaline, transparent, elastic, cellular tissue, was developed. This cord reached, gradually extending after several hours, a length of 110—120 mm., and a thickness of 4 mm. It bore on both sides, almost placed by pairs, seventeen sporangia-utricles, likewise swollen. The utricles of elongated form were fixed by stalk-like attenuations to the cord and placed near each other at its inner side. Each of these showed, as the (placental) cord itself on the exterior side, a more solid line consisting of long, narrow cells, forming a sort of midrib. To this are attached, at the inner side, the sporangia equally on short stalks. The indusium of the sori consists of a single stratum of large, tubular, thin-walled cells. The cells of the vermicular cord are ovate-roundish. The sporangia, as well of the large as the small spores, consist of utricles, formed by a simple, extremely tender, cellular stratum. After protrusion, the micro-sporangia are seen densely arranged around the much longer macrosporangia and cover the latter partially. The yellow microspores, visible through the transparent indusium, give to the utricles (sporangia) a spawn-like appearance. The microsporangia appear at first white. In the closed dry fruit, the sori are placed transversely from the back to the ventral margin, in alternate horizontal layers. These conditions agree thus far in general with the statements of the investigators quoted. Bischoff (die Cryptogamen-Gewaechse 63) regarded the sori in their horizontal superposition as fruit cells.

All around the suture of the fruit is placed a torulose ring, which consists, in a dry state, of horny, cellular tissue, stronger developed on the dorsal than on the ventral side of the fruit. To this ring the sporangia-utricles are attached as well with their stalks as with their apex. This ring, as soon as brought in contact with water, absorbs it with avidity, enlarges visibly in all directions, and expands into the gelatinous cord, thereby seceding all around from the valves of the fruit.

In repeating this experiment with another fruit placed in tepid water, the above process was exhibited in still greater completeness.

The fruit had been lying for a week without alteration in cold water. It was now like the other, slightly carved at the ventral suture. Already a quarter of an hour afterwards the valves opened on the ventral side and the anterior half of the gallert-cord protruded, drawing with it the adherent summits of the sori. After the anterior half ring emanated, the water gained easier access to the posterior part of the fruit, and the stronger half of the placental cord placed there began to bend forward with great velocity from both sides.

In the meanwhile the sori were unable to follow the ring whilst it rounded itself and widened, and then they broke one after the other at the weaker place of junction, namely from the anterior half ring, which, however, retained, as vestiges of their points of affixion, a corresponding number of cicatrices. The sori, by this breaking off, were simultaneously opened. After the lapse of about an hour the whole cord had protruded as a closed ring. In this state the ring remained for three days in water unaltered, maintaining thus a normal form. The perhaps more frequent appearance of a torn and then vermicular cord is easily accounted for by its vulnerability at the points of construction. A portion of the ring may perhaps also be destroyed when the water only penetrates by gradual decomposition of the valves, whilst the artificially promoted ingress of the water is favourable for the development of the process in its perfection.

Observing the volumen of the swollen sori-cord in comparison to its original size in the dry fruit, it will be patent that an at least 200 fold enlargement took place. It was therefore of interest to analyse this mechanism.

The fruit-valves, as already in particular sketched by Mettenius, consist of layers of cellular tissue of very different structure. The exterior one consists in a ripe state of the remnants of a cutaneous layer formed by roundish thick-walled cells, which contain a granular substance. Beneath this follow two layers of prismatic cells, which stand perpendicular to the surface-stratum and possess very thickened and lignescent walls, so that their lumina, which contain yet a little granular matter, are only observable at both extremities, but are obliterated in the middle. The exterior one of these layers is formed again of two substrata of small cells, whilst the interior one is formed of an almost single stratum of larger cells. The former is of pale yellow, the latter of brown yellow colour. These strata of cells seem to prevent the ingress of water into the unvulnerated fruit. On these strata again is deposited at the inner side a tissue of parenchymatic thick-walled cells, of which the first row, in consequence of their variable size and form, leaves many vacant places between them. The following ones become gradually more thinly walled and more ample. On the inner limits of this stratum cease the anastomosing vascular bundles of the fruit-valves, as already pointed out by Mettenius. This inner parenchym, in fruits not perfectly ripe, is densely filled with starch, of which even the similar cells of the surface-layer participate.

In fruits perfectly ripe the starch is no longer extant, being probably consumed in the formation of gelatinous substance, and the remnants in the cavity are only coloured yellow by iodine.

This parenchym passes now internally into that which forms the subsequent gelatinous cord. It consists of cells so closely pressed to each other as to render their structure not readily recognised. Under water, however, they swell instantly, not so under acetic acid. The cells maintain, under the acid, not only their original form, but walls and contents become in a different degree transparent, and thereby suddenly and with marked outlines recognised. The contents of the cells becomes apparently somewhat contracted and shows a strong refractive power. The cell-walls swell a little. These are seen thereby in a direction against the walls compressed, and on places bent into many smaller and larger folds. In the middle of each cell, a granular-membranous compressed residue of the former envelope of the cell contents becomes visible. Between this and the cell-wall, which consist of cellulose, the whole place is equally filled with a solid, transparent substance, in which no distinct stratification was visible. The whole mass is in this state fragile and of a rectangular fracture. If to a dry, thin, transverse section of this a drop of water is brought, a violent endosmosis commences. With rapid velocity the exterior cells are swelling, without exhibiting a stratification or finer structure of the contents of the cells, which becomes equally hyaline.

The cell-walls emanate instantly and well defined, and their folds and bends are seen laevigated and expanding, until all have assumed an equal roundish form, such as to the formation of the placental cord is necessary. In the interior of each cell remains the remnant of the inner utricle suspended in mucus. Its granular contents are coloured yellow by iodine.

The cells, when expanded under water, remain several days unaltered without ejecting any of their contents. They form an elastic, lubricous mass with smooth surface. At last the whole vanishes without residue in water. This cellular tissue expands also in hydrochloric and nitric acid, which dissolve the contents of the cells. Solution of potassa penetrates them but slowly. Oils, concentrated sulphuric acid, ether and alcohol, as well as acetic acid, are imbibed by the dry contents of the cells. In oils it remains unaltered. Sulphuric acid dissolves first the gelatinous substance, which is now blue precipitated by iodine, and thereafter the cell-walls. Alcohol draws from the softened contents of the cells water, and precipitates them as a granular sediment. The cell-walls and inner utricles remain intact and collapsed. With acetic acid the gelatinous mass coagulates. The reagents, which indicate combinations of nitrogen, remain without influence on the gelatinous contents and walls of the cells.

This gelatinous substance arrays itself consequently in the group of cellulose, although it remains characterised by its extreme power of endosmosis, and its absolute inability to diffuse itself in water through the cell-walls. It approaches nearest to the kinds of mucus from the exterior cells of seed teguments described by Hofmeister, in den Berichten der Koeniglich Saechsischen Gesellschaft der Wissenschaften, 1858, p. 18, and by Cramer, in his pflanzen-physiologischen Untersuchungen, fasc. III., p. 1. These, however, are generally distinct metamorphic productions of cell-walls and of a distinct structure, whereas the Marsilea mucus is deposited as an homogenous interior mass within the cavity of the cell. A chemical analysis could not be instituted with the scanty quantity available.

The rapid dissemination of the spores is consequently effected by the deposition of a strongly endosmotic substance within cellular tissue, of which the walls by folds attain such a dimension as to expand within a short period to their 200 fold volumen. The cells of the indusia are empty in the dry state, but finely rugulose. They are only passively extended by the expanding ring and sporangia.

Since the rapid expansion of the contents of the fruit experimented upon, rendered it likely that the spores were fit for germination, every care was bestowed on them, and this not without success. The prothallia developed themselves, not only of those fruits which burst under ordinary temperature, but, to my surprise, a development was also noticed, of the spores of those fruits which had been exposed to the temperature of boiling water for a quarter of an hour, the exclusion of the water having left the contents of the spores chemically and physically unaltered. In one instance the emanation of the spores from the indusia was already in force after twelve hours. The sporangia burst ; microspores (androspores) protruded by the expanding gelatinous covering, collected before the orifice of the indusium on the surface of the water, and sank after the solution of the latter.

The microspores (gynospores) emanated more tardily, many required to be liberated from the tough indusium.

The structure and the first stadia of development of both kinds of spores have been subjects of researches by Hofmeister, Naegeli and others.

The gynospores are comparatively large. Their gelatinous covering shows on the vertex many distinct layers, of which the outer ones are thicker than the inner ones.

I was able to discern the structure of the thick exosporium with distinction. It consists of prismatic, almost hexagonal, tubes, which stand in a vertical position, and these are at the base and apex closed with a membrane. The interior rather thickish membrane, which has a yellowish granular appearance, consists, according to Hofmeister, of two layers. The main content of the gynospores consists of oil, of protein substances, and of large starch grains of singular form. The latter are compound, multilaminar, the pale laminæ being granular.

The exterior covering of the androspore is similar to that of the gynospore, but of more simple structure, and somewhat torulose. The endosporium is flexible, consists of cellulose, and protrudes often with the contents.

In favourable cases the prothallia of the microspores were developed for fecundation in twenty-four hours after the evacuation of the spore contents. They consist of a conspicuous tumulus of cells, surrounded only on the base by the lobes of the inner membrane of the spore. The four orificial cells of the archegonium are distincily visible at the apex as papils. The central cell, however, lies deeply concealed, covered by two strata of cells.

When the prothallia, with their archegoniums, were so far developed that fecundation could be expected, I noticed, in all specimens examined, a remarkable appearance. On the bottom of the funnel-shaped entrance was noticed a remarkably vivid motion of molecules, which concentrated themselves around the orifice of the archegonium. Although they moved in the wider circumference of the funnel-shaped entrance, it was evident that the aim of the motion was immediate before the orifice. This motion had great resemblance with that of the mouth openings of the vorticellæ. The majority of the molecules showed a corresponding size and an oblong form. I did not succeed in detecting the immediate cause of this motion. Its vehemency did not seem to admit of its being regarded as simply molecular motion caused by chemical action, but points rather to its connection with the process of fecundation. A few hours afterwards all the archegonia had their orifices brown, the motion before it had ceased, but many were filled with a granular mass, which I must regard as the molecules now at rest.

It is remarkable that the development of the androspores is in general slower than that of the gynospores. Whilst protruding they all contained starch grains. Later, many were filled with cellular substance, which, with iodine, was coloured yellow. The cells on opening emanated either in their entirety and showed a granular content, or, instead of this, the inner parts of the spore had disintegrated into little yellow granules, with remains of the molecules rotating in the orifice of the archegonium. The case, that cells were evacuated similar to those of the moving spiral filaments, was, in the beginning, of rarer occurrence than afterwards.

The prothallia showed now a rapidly progressing development. Already, after twenty-four hours, it formed numerous radical fibres. Then an excrescence of the prothallia took place into a many-lobed, irregular body, from the depressed vertex of which the archegonium orifice often emanated to considerable height.

Art. XXXIV.—*Notes on Gastrolobium grandiflorum.* By Ferdinand Mueller, M.D., F.R.S.

[Read 18th July, 1864.]

The poison plant, of which specimens for my inspection were submitted by the Royal Society of Victoria, and which proved so detrimental to the herds and flocks in some places on the Cape River, and on the sources of the Burdekin and Flinders River, is botanically known as *Gastrolobium grandiflorum.* It is a leguminous bush, several feet high, with orange-yellow flowers, the latter imparting to it a very ornamental aspect. J. Macdouall Stuart, the famous explorer, brought the first specimens from Attack Creek, south of Arnhem's Land, and from these the species was established in the *Fragmenta Phytographiæ Australiæ*, iii. 17. It is much to be feared; that this plant has a wide range through the interior of tropical Australia (though it was not met with on the route of the expedition to which I was attached), and